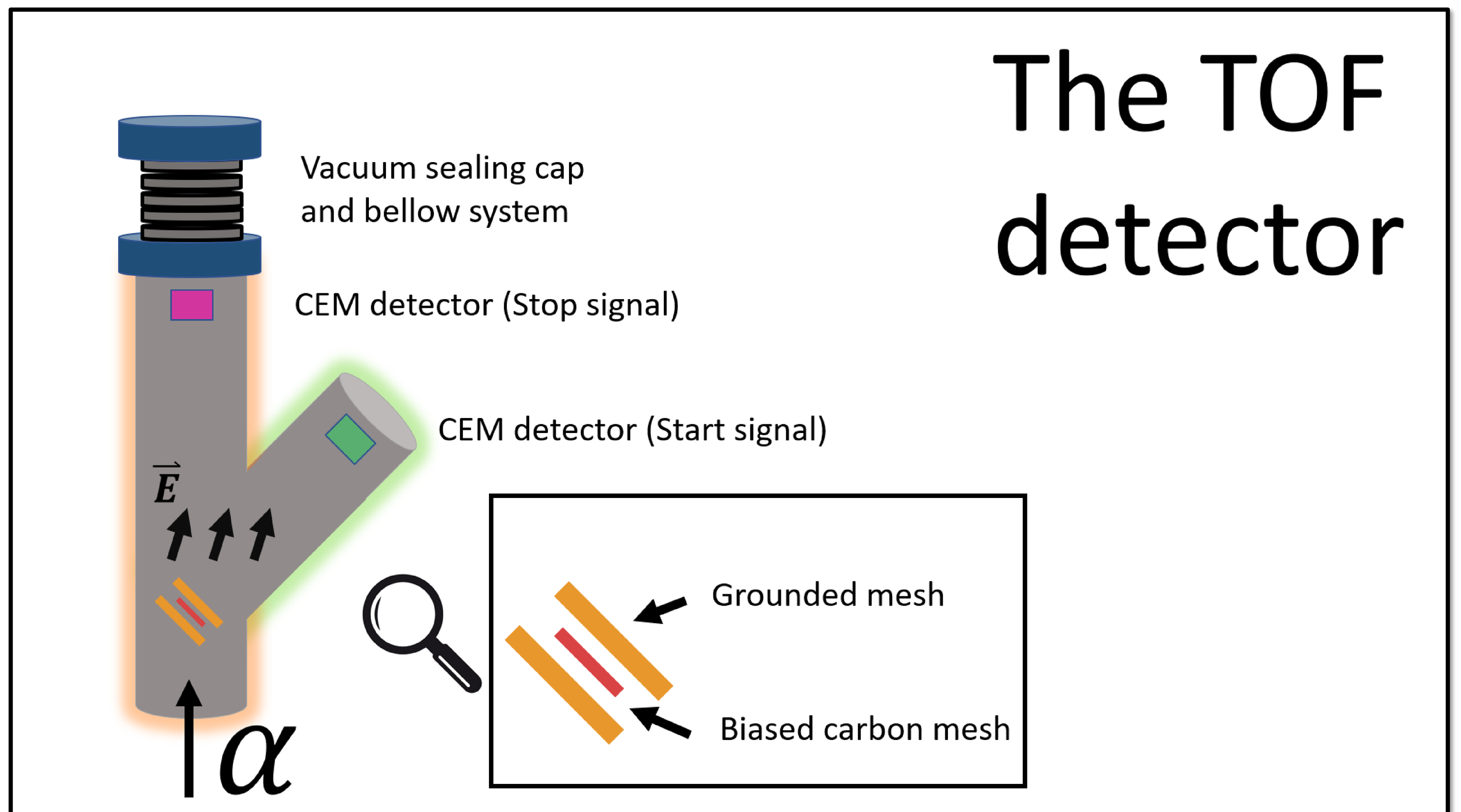
Calculating the E-Field inside a Time-of-Flight detector

Michael Fabrizio, Noah Helburn, Kurt Fletcher
– SUNY Geneseo

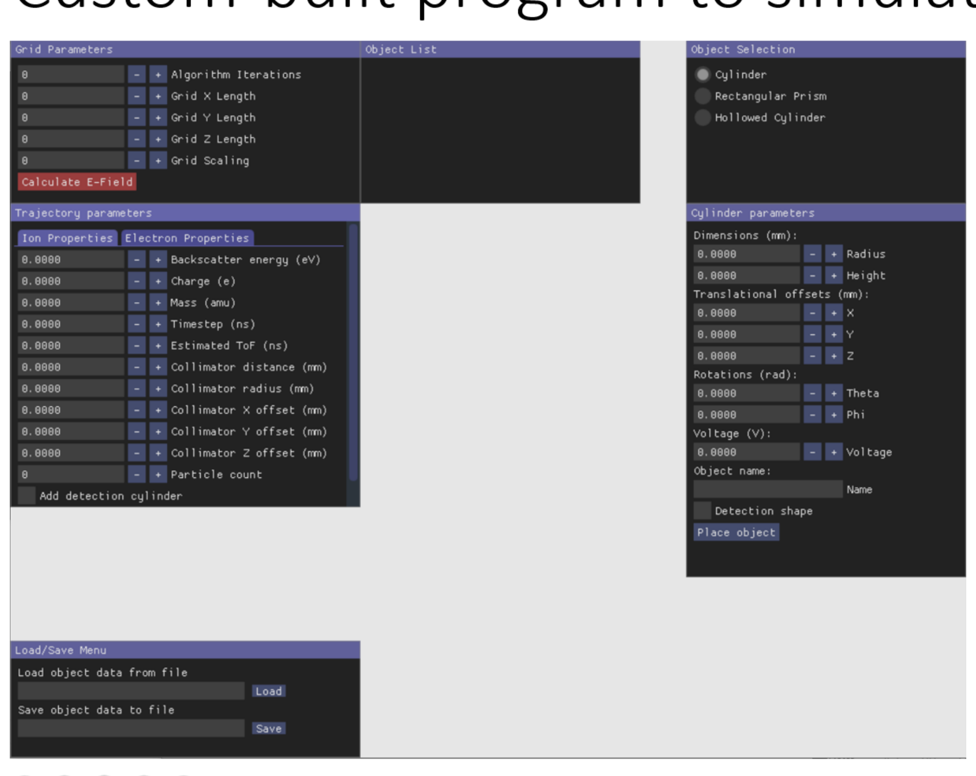
Time-of-Flight (TOF) detection



Research is underway at SUNY Geneseo's Low Energy Ion Facility (LEIF) with the goal of understanding material composition using Rutherford backscattering spectroscopy (RBS) techniques. Low energy ions are well suited to understanding the elemental composition of targets also fabricated within the same facility. TOF spectroscopy will likely one day image materials of high density to a high degree of precision, and for a relatively low cost-basis. Many parts within a TOF detector are placed under a voltage bias in order to attract the backscattered alpha particle. The resulting electric field inside the TOF detector could theoretically deflect alpha particles away from their intended target. Computational models have been built to determine the extent of alpha deflection within the chamber and give predictive measurements for the expected alpha flight time.

Methodology & Tools

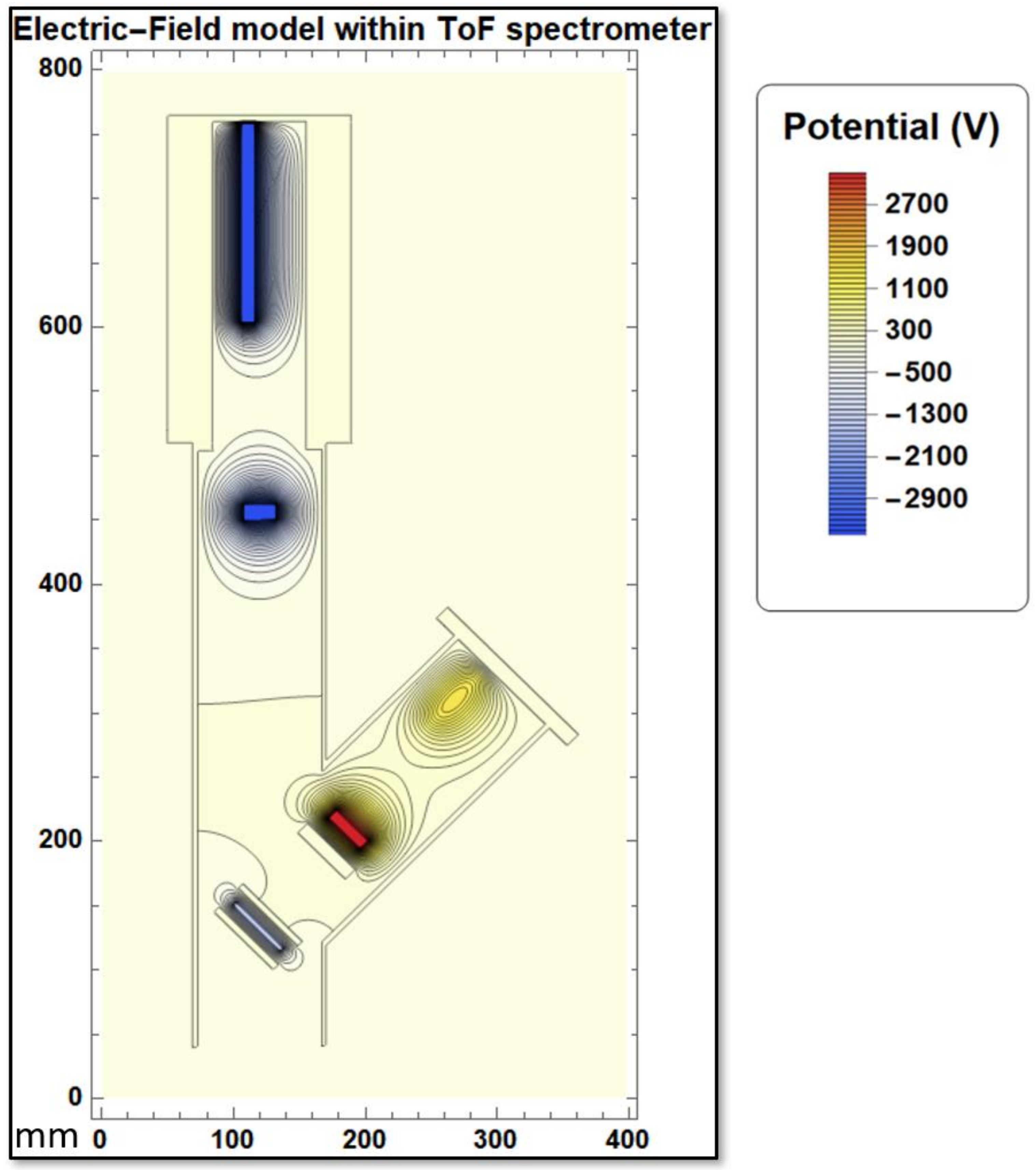
Custom-built program to simulate E-Field



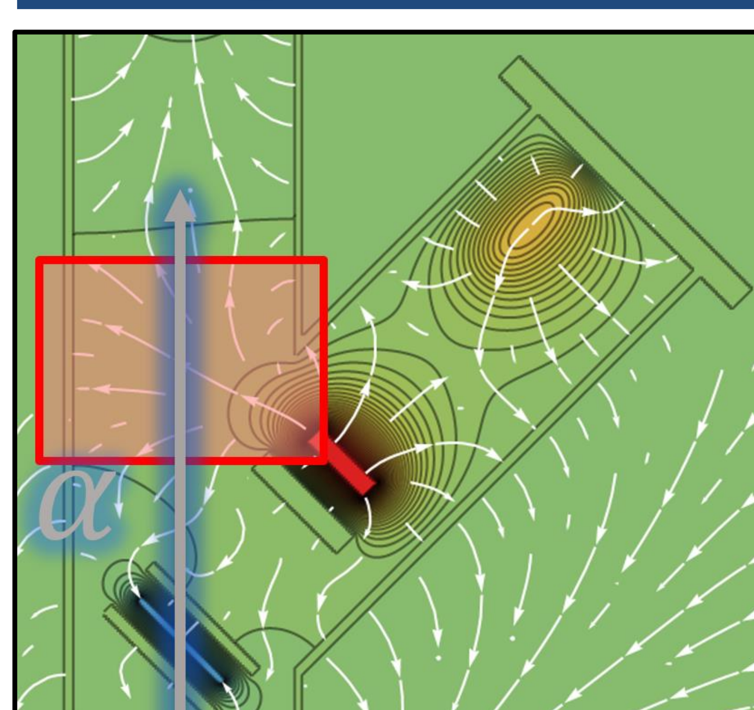
Features

- 3D Laplacian approximation
- Capable of modelling various shapes constrained at a voltage bias
- Supports calculation of electric fields and charged particle trajectories using a 4th order Runge-Kutta method
- 3000 lines of code

Electric potential approximation



Interpretation

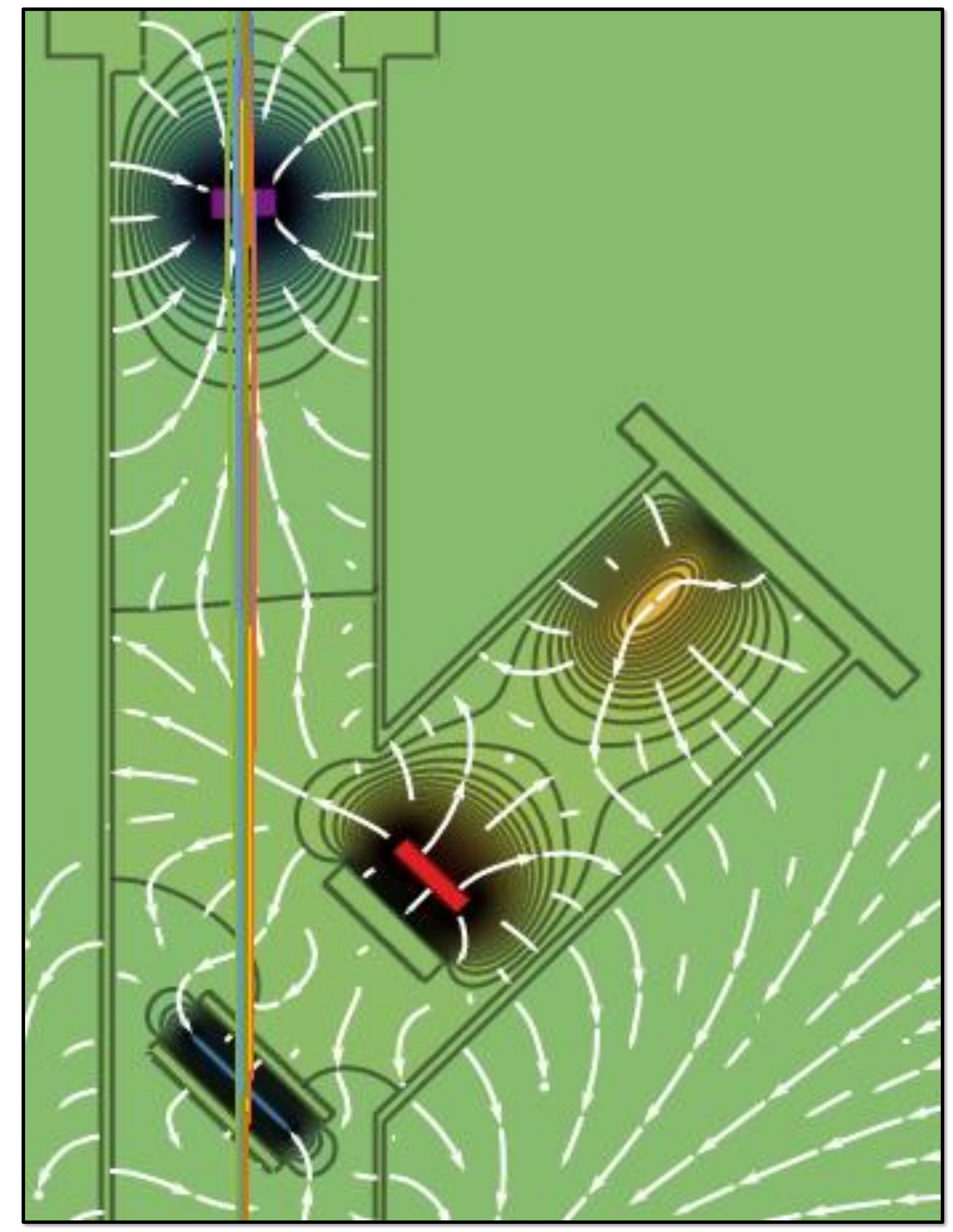


- A key zone of deflection occurs here
- Luckily, the E-Field is not strong enough to significantly push the alpha off course

Acknowledgements

Supported in part by the U.S. Department of Energy through the Laboratory for Laser Energetics

Alpha trajectories



Conclusion

- The findings suggest there is no significant alpha deflection along its flight path. Further research is underway to predict alpha flight times at higher precision, and to predict time delays caused by electron travel times within the chamber.
- Accurately modelling the internal electric field allows greater energy resolution of the backscattered alpha ions, which leads to higher precision for identifying materials
- Time-of-Flight detectors will potentially give a new method of measuring of low energy ions

The ability to measure alpha ion energies accurately will give insight into the material composition of targets by using a low energy ion source such as a duoplasmatron at SUNY Geneseo.